Analogue Filter Design

By Harry Baggen

In electronics, filters are required for all sorts of applications, ranging from a simple audio circuit to the speech processor in a GSM phone. Filter theory being complex stuff for the average electronics worker and certainly no part of everyday chores, a couple of Internet addresses may come in handy if you're suddenly faced with selecting and dimensioning a filter for an application on hand. In this month's instalment of Electronics Online we look at a dozen or so calculation aids for analogue filters.

Electronic filters represent a complex matter which is not, or not fully, mastered by many electronics enthusiasts. Not to worry, because lots of professional engineers will also admit defeat to the niceties of modern filter design. Fortunately, neither the hobbyist nor the professional worker needs to have a few dozen equations in his head — what matters is to know where the information can be found when it is needed. To help you on the way, and perhaps add a few bookmarks in your Favourites folder, we searched the Internet for software tools that considerably lighten the job of passive and active analogue filter design.

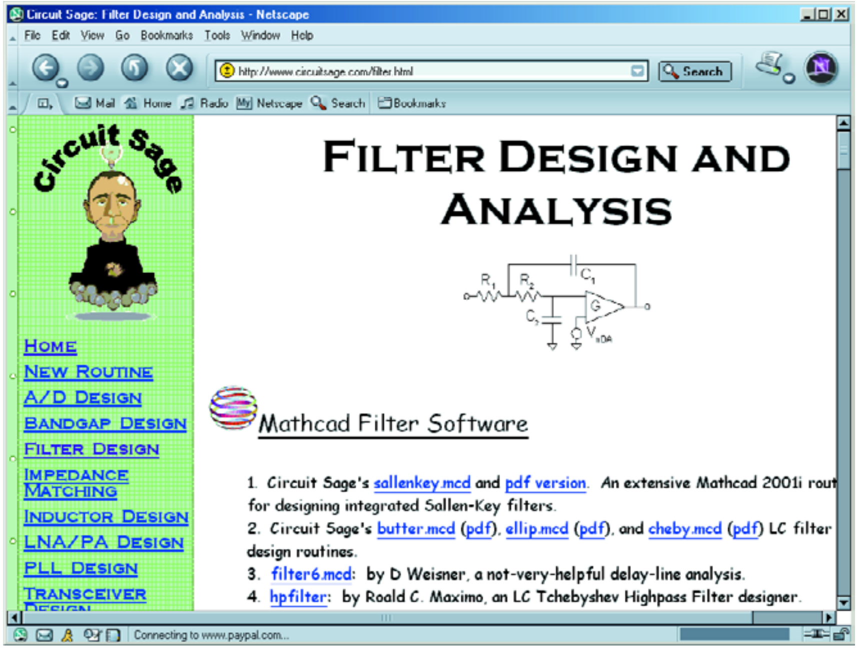
An excellent point to start from when you need filter information in the widest sense is **Circuit Sage** [1]. Set up a number of years ago by a bunch of IC designers, this website covers a vast range of electronic designs. With each subject, the designers themselves make relevant information available, or point the way to other sources on the web. Looking under the heading 'Filter Design' the list starts with a number of calculations intended for use with the familiar MathCad mathematics program. Various types of low-pass and high-pass filters are available in passive as well as active guises.

If you can not, or do not want to, work with MathCad, the second list on this web page contains addresses of alternative filter calculation programs.

From the latter group we made a selection, with an eye for software that's offered free of charge. We begin with a number of calculation tools that can be run directly off the relevant website.

Analog Devices on their massive website [2] offer a number of online calculation aids for active filters. The scripts allow second-order through eighth-order high-pass, low-pass and band-pass filters to be dimensioned, enabling you to select between filter responses like Bessel, Butterworth and Chebyshev, all with various ripple responses.

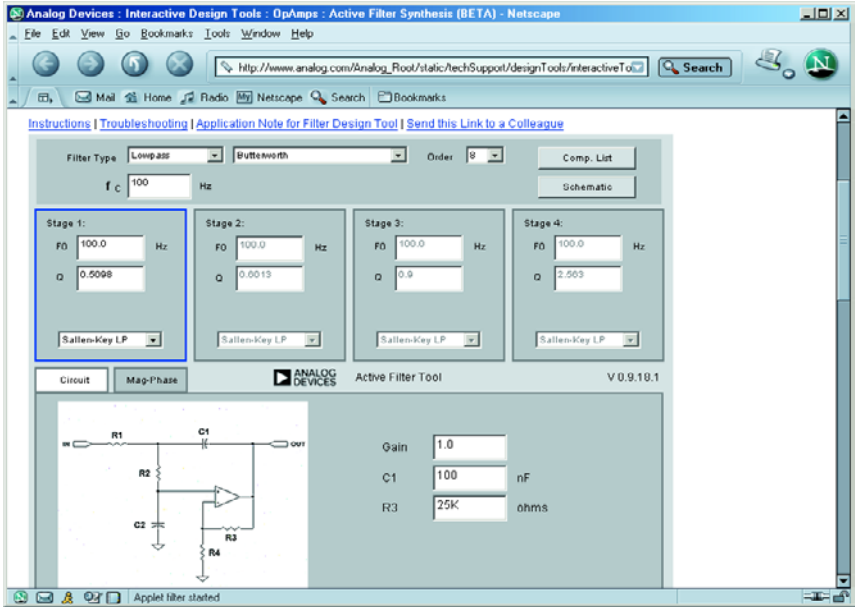
A helping hand for passive filter design is offered by various tools on the **Max Froding** website [3]. We found a page discussing the design of passive Butterworth filters (high- or low-pass) with up to 25 ele-


Circuit Sage: Filter Design and Analysis - Netscape
File Edit View Go Bookmarks Tools Window Help
http://www.circuitsage.com/filter.html
Search
Mail Home Radio My Netscape Search Bookmarks
Circuit Sage
HOME
NEW ROUTINE
A/D DESIGN
BANDGAP DESIGN
FILTER DESIGN
IMPEDANCE MATCHING
INDUCTOR DESIGN
LNA/PA DESIGN
PLL DESIGN
TRANSCEIVER DESIGN
R1
R2
C1
C2
G
VxDA
Connecting to www.paypal.com...

FILTER DESIGN AND ANALYSIS

Mathcad Filter Software

1. Circuit Sage's sallenkey.mcd and pdf version. An extensive Mathcad 2001i rout for designing integrated Sallen-Key filters.
2. Circuit Sage's butter.mcd (pdf), ellip.mcd (pdf), and cheby.mcd (pdf) LC filter design routines.
3. filter6.mcd: by D Weisner, a not-very-helpful delay-line analysis.
4. hpfilter: by Roald C. Maximo, an LC Tchebyshev Highpass Filter designer.



Analog Devices : Interactive Design Tools : OpAmps : Active Filter Synthesis (BETA) - Netscape

http://www.analog.com/Analog_Root/static/techSupport/designTools/interactiveTo

Filter Type: Lowpass, Butterworth; Order: 8

f C: 100 Hz

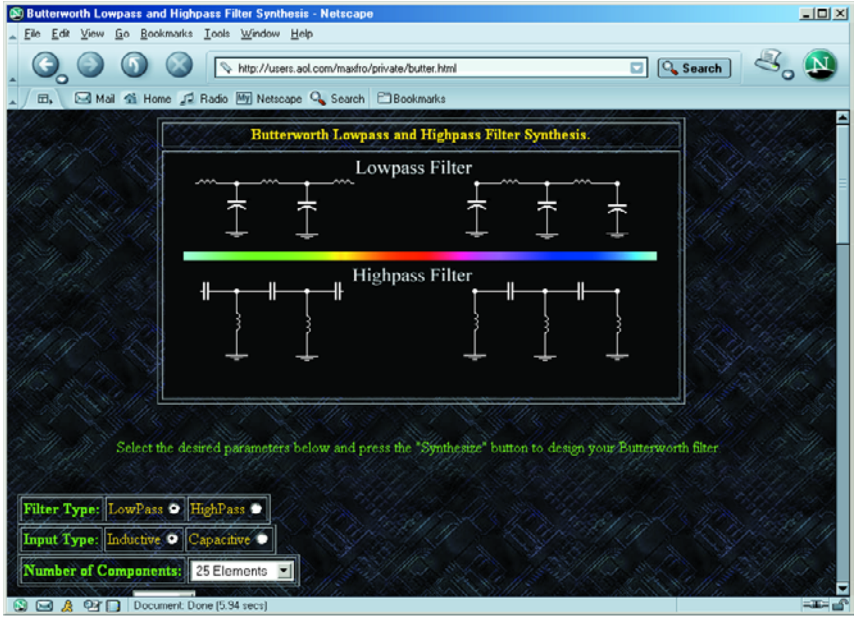
	Stage 1:	Stage 2:	Stage 3:	Stage 4:
F0 (Hz)	100.0	100.0	100.0	100.0
Q	0.5098	0.6013	0.9	2.563
	Sallen-Key LP	Sallen-Key LP	Sallen-Key LP	Sallen-Key LP

Gain: 1.0

C1: 100 nF

R3: 25K ohms

Applet filter started



Butterworth Lowpass and Highpass Filter Synthesis - Netscape

http://users.aol.com/maxfro/private/butter.html

Butterworth Lowpass and Highpass Filter Synthesis.

Select the desired parameters below and press the "Synthesize" button to design your Butterworth filter

Filter Type: LowPass ● HighPass ○

Input Type: Inductive ● Capacitive ○

Number of Components: 25 Elements

Document: Done (5.94 secs)

ments. Another page helps you compute passive elliptical (or Cauer) band filters.

Tony Fishet's interactive **LC Filter Design** page [4] is certainly worth trying. Although graphically less sophisticated that the above websites, Tony's pages look technically sound and it's results that count at the end of the day.

Software for the design and simulation of filter responses has always been pricey. Fortunately, a few programs are available at no cost at all.

To begin with, we should mention Burr Brown's **Filter Perfect**. A bit dated, maybe, but still a great piece of DOS (!) software, it can be downloaded from the **RF Tools** website [5] under the name *Burr Brown Filter Designer Software*. These days TI supply a revamped version running under Windows under the name **FilterPro** [6]. The program suite computes Sallen and Key or multiple feedback constellations with a Bessel, Butterworth or Chebyshev response.

Linear Technology [7] also offers a few filter programs that are certainly worth your thorough examination and practical use — the names are **FilterCAD** and the **Filter Design Guides** for the LT1567 and LT1568. Although the programs assume you're using LT integrated circuits, they're easy to adapt to similar products from other manufacturers.

Filterlab from Microchip [8] is another dimensioning program for active Bessel, Butterworth and Chebyshev filters up to eighth order (low-pass, high-pass and band-pass). The program is easy to use, allowing you to view a simulation of the frequency and phase response immediately after the filter dimensioning operation.

Tunekit 2.0 [9] is a small Windows program written by Max Froding. It is suitable for Chebyshev low-pass and high-pass filters comprising 2 to 25 poles, band-pass and notch filters. The program has been designed as a front-end to the famous ARRL Radio Designer and so allows your filter to be analysed straight away.

Finally, those of you interested in 'big gun' programs only should follow these links to demo versions that provide excellent introductions to filter dimensioning: **Filtroid** by Gigasim [10], **Filter Master** by Intosoft [11], **Super Filter** by Those Engineers [12] and **Quickfil** by Omicron [13].

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Internet Addresses

[1] Circuit Sage: www.circuitsage.com/
[2] Analog Devices Interactive Design Tools: www.analog.com/Analog_Root/ static/techSupport/designTools/interactiveTools/filter/filter.html
[3] Max Froding filter calculations: http://users.aol.com/maxfro/private/butter.html
http://users.aol.com/maxfro/private/cauerbpf.htm
[4] LC Filter Design: www-users.cs.york.ac.uk/~fisher/lcfilter/
[5] RF Tools: http://rfengineer.cc/rftools.htm
[6] FilterPro: http://focus.ti.com/analog/docs/sampleutilities.tsp?path=templatedata/cm/utilities/data/filterpro&templateId=3&familyId=57&navigationId=9742
[7] Linear Technology filter software: www.linear.com/software/
[8] Filterlab: www.microchip.com/1010/pline/tools/analog/software/flab/10626/index.htm
[9] Tunekit 2.0: http://members.aol.com/maxfro/private/tunekit2.html
[10] Filtroid: www.gigasim.com/gsFiltroid.html#anchor647705
[11] Filter Master: www.i-t.com/engsw/intusoft/filtrmstr.htm
[12] SuperFilter: www.spiceage.com/demo.htm
[13] Quickfil: www.omicronsw.com/downloads/swdemos/index.html